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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5) 09/091805	
INTERNATIONAL APPLICATION NO. PCT/JP97/03833		INTERNATIONAL FILING DATE October 23, 1997		PRIORITY DATE CLAIMED October 24, 1996	
TITLE OF INVENTION CHOKE COIL					
APPLICANT(S) FOR DO/EO/US Toshiyuki NAKATA; Koji NAKASHIMA; Katsunori OMURA; Kiyoshi TAKAGI					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
1 <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2 <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3 <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). 4 <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. 5 <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)) a <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b <input checked="" type="checkbox"/> has been transmitted by the International Bureau. c <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6 <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). 7 <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210). 8 <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) a <input checked="" type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b <input type="checkbox"/> have been transmitted by the International Bureau. c <input type="checkbox"/> have not been made, however, the time limit for making such amendments has NOT expired. d <input type="checkbox"/> have not been made and will not be made. 9 <input checked="" type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 10 <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). 11 <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409). 12 <input checked="" type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).					
Items 13 to 18 below concern document(s) or information included:					
13 <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 14 <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 15 <input type="checkbox"/> A FIRST preliminary amendment. A SECOND or SUBSEQUENT preliminary amendment. 16 <input type="checkbox"/> A substitute specification. 17 <input type="checkbox"/> A change of power of attorney and/or address letter. 18 <input checked="" type="checkbox"/> Certificate of Mailing by Express Mail. 19 <input checked="" type="checkbox"/> Other items or information:					
International Publication					

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 1.5)		INTERNATIONAL APPLICATION NO.		ATTORNEY'S DOCKET NUMBER	
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20 The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (I) - (5)) : X Search Report has been prepared by the EPO or JPO \$930.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$700.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$770.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$1,040.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4). \$96.00				CALCULATIONS (PLEASE ONLY)	
ENTER APPROPRIATE BASIC FEE AMOUNT =				930.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE:		
Total claims	24 - 20 =	4	X \$22.00	88.00	
Independent claims	1 - 3 =	0	N \$82.00		
Multiple Dependent Claims (check if applicable)					
TOTAL OF ABOVE CALCULATIONS =				1148.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).				0.00	
SUBTOTAL =					
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				0.00	
TOTAL NATIONAL FEE =					
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).				0.00	
TOTAL FEES ENCLOSED =				1148.00	
				Amount to be refunded	\$
				charged	\$

09/091805

CHOKE COIL**Field of the Invention**

The present invention relates to a choke coil utilized in electronic products both for consumer
 5 and industrial uses.

Background of the Invention

Thanks to the development of various electronic devices, electronic products have become smaller and thinner in size, consume power, and have better performance. And yet, the
 10 market's demand for the better products still continues. In order to meet this demand, a power supply section, particularly in a switching power supply, has struggled with the following three major demands: 1. accommodating a higher switching frequency, 2. employing a higher density of parts mounting, particularly when utilizing surface mounting techniques, 3. accommodating a large current responsive to a higher performance of semiconductor, etc. Accordingly, a demand
 15 has arisen for a choke coil, one of the major parts of the switching power supply, having a smaller loss, that accommodates a larger current, and is smaller and thinner for use with surface mounting techniques.

A conventional thin-type choke coil well known in the market is illustrated in Figs. 47 through 51. Fig. 47 is an exploded perspective view, Fig. 48 is a perspective view depicting the
 20 coil incorporated with a closing magnetic core. Fig. 49 is a perspective view depicting a complete product. Fig. 50 is a cross section, and Fig. 51 is a top view depicting the coil from which one magnetic core is removed.

The following elements are illustrated in the above Figs.: flat type wire 1 covered by an insulated material, coreless coil 2, an inner turn 3 of the coreless coil 2, an outer turn 4 of the
 25 coreless coil 2, a terminal 5 of the inner turn 3, a terminal 6 of the outer turn 4, a center magnetic leg 7, an outer magnetic leg 8, a common magnetic yoke 9, a closing magnetic core 10 of magnetic field, an insulating paper 11, a window height 12 of the closing magnetic core 10. The structure of the conventional thin-type choke coil is as follows: The coreless coil 2 is formed by coiling the flat type wire 1. The inner terminal 5 and the outer terminal 6 are coupled with an
 30 inner turn 3 and outer turn 4 of the coreless coil 2 respectively by e.g., soldering. The coreless coil

Brief Description of the Drawings

Fig. 1 is an exploded perspective view of the choke coil in the first exemplary embodiment according to the present invention.

Fig. 2 is a perspective view depicting the coreless coil mounted to the terminal base
5 illustrated in Fig. 1.

Fig. 3 is a perspective view of a completed product shown in Fig. 2.

Fig. 4 is a top view depicting the assembled elements illustrated in Fig. 3 including the coreless coil, the terminal base and E-shape magnetic core.

Fig. 5 is a cross section of the completed product shown in Fig. 4.

10 Fig. 6 is a perspective view depicting an example of a pin terminal.

Fig. 7 is a perspective view depicting an example of TU-shape magnetic core.

Fig. 8 is a top view depicting a modification of E-shape magnetic core.

Fig. 9 is a top view depicting the coreless coil mounted around the E-shape magnetic
core.

15 Fig. 10 is an exploded perspective view depicting the choke coil utilized in the second exemplary embodiment of the present invention.

Fig. 11 is a perspective view depicting the coreless coil mounted to the terminal base
illustrated in Fig. 10.

Fig. 12 is a perspective view depicting the assembled elements illustrated in Fig. 10
20 including the coreless coil, the terminal base and E-shape magnetic core.

Fig. 13 is a perspective view depicting an insulating paper incorporated into the status
shown in Fig. 12.

Fig. 14 is a perspective view of a complete product depicted in Fig. 13.

Fig. 15 is a perspective view of the assembled elements illustrated in Fig. 10 including
25 the coreless coil, the terminal base and E-shape magnetic core.

Fig. 16 is a cross section of the complete product depicted in Fig. 14.

Fig. 17A and Fig. 17B are a top view and a front view depicting the coreless coil before
it is coiled.

Fig. 18 is a top view of the coreless coil depicted in Fig. 17.

Fig. 19 is a top view of another coreless coil.

Fig. 20 illustrates inconvenience in coupling the terminals of the coreless coil.

Fig. 21 illustrates a method of coupling the terminals where a spacer is used.

Fig. 22 is a cross section depicting an I-shape magnetic core having a cavity.

5 Fig. 23 is a cross section depicting inconvenience when the I-shape magnetic core does not have the cavity.

Fig. 24 is an exploded perspective view depicting a cylinder being separated from the terminal base.

10 Fig. 25 is an exploded perspective view depicting the coreless coil being incorporated into the cylinder.

Fig. 26A through Fig. 26C are a top view, side view and front view depicting the E-shape magnetic core.

Fig. 27A and Fig. 27B are a bottom view and a front view depicting the I-shape magnetic core.

15 Fig. 28A and Fig. 28B are a bottom view and a front view depicting another I-shape magnetic core.

Fig. 29 is an exploded perspective view of the choke coil utilized in the third exemplary embodiment according to the present invention.

Fig. 30 is a perspective view of a complete product depicted in Fig. 29.

20 Fig. 31 is a cross section of the complete product depicted in Fig. 29.

Fig. 32 is an exploded perspective view of the choke coil utilized in the fourth exemplary embodiment according to the present invention.

Fig. 33 is an exploded perspective view of the assembled elements illustrated in Fig. 32 including the coreless coil, terminal base, I-shape magnetic core and the insulating sheet.

25 Fig. 34 is a perspective view of a complete product depicted in Fig. 33.

Fig. 35 is a cross section of the complete product depicted in Fig. 33.

Fig. 36 is an exploded perspective view depicting the choke coil utilized in the fifth exemplary embodiment according to the present invention.

Fig. 37 is a perspective view depicting the assembled elements illustrated in Fig. 36 including the coreless coil and the terminal base.

Fig. 38 is a perspective view depicting the assembled elements illustrated in Fig. 36 including the coreless coil, terminal base, E-shape magnetic core.

5 Fig. 39 is a perspective view depicting the insulating sheet being further assembled with the elements illustrated in Fig. 38.

Fig. 40 is a perspective view of a complete product depicted in Fig. 36.

Fig. 41 is a cross section of the complete product depicted in Fig. 36.

Fig. 42 is an exploded perspective view of the choke coil utilized in the sixth exemplary
10 embodiment.

Fig. 43 is a perspective view depicting the choke coil on the way of assembly.

Fig. 44 is a perspective view of a complete product illustrated in Fig. 42.

Fig. 45 is a cross section of the complete product.

Fig. 46 is a front view of a coreless coil before being coiled and used in the sixth
15 exemplary embodiment.

Fig. 47 is an exploded perspective view of a conventional choke coil.

Fig. 48 is a perspective view depicting the assembled elements in Fig. 47 including the coreless coil, terminal base and E-shape magnetic coil.

Fig. 49 is a perspective view of a completed product depicted in Fig. 47.

20 Fig. 50 is a cross section of the completed product.

Fig. 51 is a top view depicting a top view of the assembled elements illustrated in Fig. 47 including the coreless coil, terminal base and E-shape magnetic core.

Description of the Preferred Exemplary Embodiment

25 The present invention is further detailed by referring to the attached drawings.

Embodiment 1

The first exemplary embodiment of the present invention is described by referring to Figs. 1-5. A coreless coil 20 comprises a coiled plate-type wire 21 made of flat type wire or foil type wire.

More specifically, a self welding flat-type-wire coils itself and is heated to soften the self welding layer, thereby welding the layers with each other and forming the coreless coil 20.

Both the ends of this coreless coil 20, i.e., an inner and an outer ends, are coupled with plate-type terminals 22 and 23, which are led out so that they protrude downward from the coreless coil 20. These terminals 22 and 23 are to be assembled into the terminal base 24. The terminal base 24 is made of insulating material such as synthetic resin, and comprises a cylinder 25, base plate 26 and a triangular protrusion 27 with which the coreless coil 20 engages. These three elements function as an insulating layer respectively.

The cylinder 25 of the terminal base 24 has a thickness deviation at a part, i.e., this part is thicker than other part, corresponding to the terminal 22 of the coreless coil 20, and has a vertical groove 28 which guides the terminal 22 engaged with the corresponding thicker part. A terminal hole 29 through which the terminal 22 extends is punched on the base plate 26 at the lower end of the vertical groove 28 and on the triangular protrusion 27. Another terminal hole 30 is punched on the base plate 26 to which the terminal 23 coupled with the outer end corresponds. Beneath the bottom face of the triangular protrusion 27, a terminal groove 31 connected to the terminal hole 29 is provided. Also beneath the base plate, a terminal groove 32 connected to the terminal hole 30 is provided. After assembling the coreless coil 20 with the terminal base 24, the protruded terminals 22 and 23 are bent, and then fit into the terminal grooves 31 and 32 so that the terminals 22 and 23 can be led out to the sides from the triangular protrusion 27 in the terminal base 24 and the corresponding end face of the base plate 26. In other words, when this type of terminal base 24 is used, the terminals 22 and 23 are led out to the opposite directions independently, i.e., led out at an angle of 180° difference with each other, and whereby the choke coil is suitably constructed for surface mounting.

A closing magnetic core 34 is incorporated with the assembled product of the coreless coil 20 and the terminal base 24. The closing magnetic core 34 is formed by E-shape magnetic core 39 and I-shape magnetic core 40, which are both made of a sintered body of manganese ferrite. The magnetic core 39 of the closing magnetic core 34 comprises a center magnetic leg 35, outer magnetic legs 36 on both sides, and a common magnetic yoke 37. On the common magnetic yoke 37 of the E-shape magnetic core 39, a notch 38 is provided in which the triangular protrusion 27

of the terminal base 24 can be fit. A cavity 41 is provided at inside center of the outer magnetic leg 36 of the E-shape magnetic core as a guide along an outer shape of the coreless coil 20, whereby the dimension of the choke coil can be further reduced.

The above structure is manufactured by performing the following operations: assemble the
5 terminal base 24 with the coreless coil 20, bend the terminals 22 and 23 along the terminal grooves 31 and 32, and fit the terminals into the grooves, then incorporate the E-shape magnetic core 39 having a cylindrical center magnetic leg 35 with the terminal base 24 from its bottom face, and fit the triangular protrusion 27 into the notch 38 so that the both elements are positioned, whereby a structure illustrated in Fig. 2 is completed. Then, incorporate insulating sheet 33 with
10 the - structure of Fig. 2, and further incorporate the I-shape magnetic core 40, thereby completing the choke coil illustrated in Fig. 3.

In this assembly, when the center magnetic leg 35 is lower than the outer magnetic leg 36 of the E-shape magnetic core 39 on both sides, the choke coil is able to have a magnetic gap 42 above the center magnetic leg 35, thereby improving the current superimpose characteristics of
15 the choke coil without increasing leakage flux from the closing magnetic core 34.

The insulating sheet 33 is made of polyester film, polyphenylenesulfide film, or aramid paper, and is inserted into the magnetic gap between the center magnetic leg 35 of the E-shape magnetic core 39 and I-shape magnetic core 40.

In the above structure, since the terminal base 24, the triangular protrusion 27 and the
20 terminals 22, 23 are placed or led out by utilizing the notch 38 of the common magnetic yoke 37, the thickness of the terminals 22, 23 does not affect the window height direction of the closing magnetic core 34. Thus the terminals 22, 23 can be enlarged both in thickness and sectional area, whereby the choke coil can accommodate a large current. Further, the coreless coil 20 is mounted on the face where the center magnetic core 35 is adjacent to the common magnetic yoke 37 of the
25 closing magnetic core 34, with insulating layers such as the base plate 26 and the cylinder 25 between the coreless coil 20 and the face. Accordingly, the coreless coil 20, the terminals 22 and 23 are prevented from being damaged during assembly, and as a result, the choke coil with the higher efficiency in assembly as well as the higher reliability can be realized.

In the above exemplary embodiment, the plate-type terminal is employed as the terminals 22, 23 coupled to both the ends of the coreless coil 20, however, a pin-type terminal as illustrated in Fig. 6 can be also employed, whereby the choke coil can be mounted in a multi-layer printed circuit board.

- 5 The E and I-shapes (EI-shape) magnetic cores are employed in the closing magnetic core 34 in the above embodiment, however, the TU-shape or EE-shape magnetic core as shown in Fig. 7 can be employed instead of the EI-shape. Although the cross sectional view of the center magnetic leg 35 of the closing magnetic core 34 shows a circle in the above embodiment, it can be an ellipse or oval so that the window width of the closing magnetic core 34 can be broadened
- 10 with regard to the sectional area of the center magnetic leg 35 as shown in Figs. 8 and 9.

When the notch 38 is provided on a first side of the common magnetic yoke 37 and not provided on a second side of the common magnetic yoke, a thickness of the second side can be 65-90% that of the first side without affecting the characteristics of the choke coil. As a result, a weight of the ferrite core can be reduced, and a height of the choke coil can be lowered.

15

Embodiment 2

- The second exemplary embodiment is described by referring to Figs. 10-16. The basic structure is same as that of the first exemplary embodiment, thus only the different points are described here. The coreless coil 20 employs the plate-type wire 21 made of self welding flat-
- 20 type-wire. The plate-type wire 21 coils itself, and forms the coreless coil 20, and the coreless coil is heated so that its shape can be retained with the self welding layer. However, external force is applied to either end of the coil to peel off, and thus the coreless coil 20 sometimes loses the coil-shape.

- The portions which retain the terminals 22 and 23, therefore, should be avoided being both
- 25 ends of the coil, and an extension part 45 is provided instead, whereby adhesion by heating is increased, and as a result, the coil is prevented from losing its coiled shape.

In addition, a bent portion 46 is provided on both the ends in a radial direction, i.e., the bent portion 46 at the inner end protrudes inward, and another bent portion 46 at the outer end

protrudes outward. This structure can prevent insulation between the layers from being damaged by the edges of both the ends of the plate-type wire 21 of the coreless coil 20.

The cylinder 25 of the terminal base 24 has a thickness deviation, i.e., the corresponding part to the inner terminal 22 of the coreless coil 20 is thicker than the other part, and the vertical
5 groove 28 is disposed on this thicker part so that the terminal 22 engaged into the groove 28 can be guided, and an engaging groove 47 is disposed within a little distance from the vertical groove 28 so that the bent portion 46 disposed at the inner end of the coreless coil 20 can be engaged with.

Regarding the terminal base 24, a support protrusion 49 is disposed at respective four corners
10 of the base plate 26 with a predetermined distance from the cylinder 25. An opposite face of the support protrusion 49 to the cylinder 25 is tapered (taper 50) so that the coreless coil 20 can be incorporated by guiding with this taper 50. In addition, a tapered notch 51 is provided on a respective support protrusion 49, and an engaging down flap 52 is provided on the respective four corners of the insulating sheet 33. Then, the flap 52 is engaged with the tapered notch 51 thereby
15 positioning the insulating sheet 33.

Another bent portion 46 disposed on the outer end of the coreless coil 20 is engaged with an end face of one of the four support protrusions 49 provided on the base plate 26.

The E and I-shapes magnetic cores 39 and 40 are used as the closing magnetic core 34. On the I-shape magnetic core 40, a cavity portion 44 is provided in order to give a relief to the inner
20 terminal 22 as well as a notch 43 is provided on an opposite edge to the notch 38 of the E-shape magnetic core 39 in order to give a relief to the outer terminal 23.

If the cavity portion 44 were not provided on the I-shape magnetic core as shown in Fig. 23, and the terminal 22 were protruded above the coreless coil 20, the upper end of the terminal 22 would hit the lower face of the I-shape magnetic core 40, and I-shape magnetic core 40 could not
25 be assembled with the E-shape magnetic core 39. However, when the cavity portion 44 is provided as shown in Fig. 22, the upper end of the terminal 22 gets a relief so that the I-shape magnetic core 40 can be assembled firmly with the E-shape magnetic core 39. The notch 43 on the I-shape magnetic core 40 also functions as well when the terminal 23 protrudes upward.

In the same structure as described above, the coreless coil 20 having an ellipse inner shape or an oval inner shape is incorporated with the terminal base 24 as shown in Fig. 11 through the following steps: first, a) incorporate the bent portion 46 of the coreless coil 20 with the terminal base 24 by engaging the bent portion 46 with the groove 47 as well as the end face of protrusion 5 49, second, b) engage the terminals 22, 23 which extends downward through respective holes 29, 30 punched in the terminal base 24 with respective grooves 31, 32, then pull out the terminals 22, 23 to an opposite side with each other, third, c) mount the E-shape magnetic core 39 to the terminal base 24 from the bottom of the base 24 as shown in Fig. 12, and then, d) assemble the flap 52 with the tapered notch 51 so that the insulating sheet 33 can be positioned into the base 10 24 as shown in Fig. 13, finally, e) mount the I-shape magnetic core 40 on the outer magnetic leg 36 of the E-shape magnetic core 39 so that the choke coil is completed as shown in Figs. 14 and 16.

The choke coil having the above structure has a lot of advantages, e.g., 1) firm positioning of the coreless coil 20 as well as the insulating sheet 33 is achieved with ease, and 2) a number of 15 defects in assembling the magnetic cores can be reduced.

The coreless coil 20 utilized in the above structure is produced through the following steps: first, a) form a bent portion 46 by bending a first end of the plate-type wire 21 at a right angle as shown in Figs. 17A and 17B, meanwhile, the plate-type wire is made of self welding flat-type-wire, second, b) remove an insulating layer from two parts located within a limited distance from 20 both ends of the wire 21 so that the two parts expose conductive material, third, c) connect the terminals 22, 23 to the exposed parts by caulking or welding, then, d) mount a spacer 48 to respective rear faces of the connected parts as shown in Fig. 21 so that a short circuit (A) as shown in Fig. 20 can be prevented. When the terminals 22, 23 are connected, a burr is produced on the face opposite to the connected part of the terminals, the burr causes a short circuit (A), and, e) coil 25 the plate-type wire and heat the wire to weld each other. Finally, f) form another bent portion 46 by bending a second end of the plate-type wire (i.e., the end of the outer most turn) as shown in Fig. 18. When the bent portions 46 and the extended portions 45 are not necessarily at the ends of coreless coil 20, the structure can be modified as shown in Fig. 19.

In the above structure, the terminal base 24 is described that the cylinder 25 and the base plate

26 are in one molding, however, those two elements can be individually made and coupled to each other by a mechanical method or with bond. In this case, as shown in Fig. 25, the coreless coil 20 can be directly wound to the cylinder, and then the base plate 26 is assembled with the cylinder. This method can improve the production efficiency.

- 5 In the above I-shape magnetic core 40, two cavity portions 44 as show in Fig. 27 can be provided in order to give a relief to the edges of the terminals 22, and 23. Instead of the cavity portion 44, a hole 44b giving a relief to the terminal 22 can be provided as shown in Fig. 28.

Embodiment 3

- The third exemplary embodiment is described hereinafter by referring to Figs. 29-31. The basic structure is same as that of the second exemplary embodiment, thus different points are only described here. The cylinder 25 of the terminal base 24 has deviates in thickness, i.e., one portion is thicker than another portion, corresponding to the inner terminal 22 of the coreless coil 20, and has a vertical groove 28 which guides the terminal 22 engaged with the corresponding thicker part. A terminal hole 29 through which the terminal 22 extends is punched on the base plate 26 and an annexed square protrusion 55 both are provided at the lower end of the vertical groove 28. Another terminal hole 30 is punched on the base plate 26 to which the terminal 23 coupled with the outer end of the coreless coil corresponds. The coreless coil 20 is assembled into the terminal base 24, and then the closing magnetic core 34 is assembled thereto. This closing magnetic core 34 comprises the E-shape magnetic core 39 and the I-shape magnetic core 40. On the common magnetic yoke 37 of the E-shape magnetic core 39, a through hole 56 is punched into which the square protrusion 55 can be fit .
- 10 15 20

On the insulating plate 57, terminal holes 58 and 59 are punched to accept the terminals 22 and 23, which extend from the bottom side of the coreless coil 20. On the rear side of the insulating plate 57, terminal grooves 60 and 61 are provided adjacent to the holes 58 and 59.

- 25 In the above structure, the coreless coil 20 is assembled into the terminal base 24, and the square protrusion 55 is fit into the through hole 56 punched on the common magnetic yoke 37 of the E-shape magnetic core 39 for positioning. Then, the terminals 22 and 23 extended from the bottom side of the coreless coil 20 is led out from the terminal holes 58 and 59. The insulating plate 57 is mounted beneath the bottom of the E-shape magnetic core 39. The terminals 22 and

23 extended from the bottom face of the insulating plate are bent so that the terminals 22 and 23 can be fit into the terminal grooves 60 and 61, and then, the terminals are led out from sides of the insulating plate 57. Finally, the insulating sheet 33 is assembled and the I-shape magnetic core 40 is assembled thereto, and the choke coil is completed as shown in Figs. 30 and 31.

- 5 The choke coil produced in the above structure has the following advantages, 1) a firm positioning of the coreless coil 20, the terminals 22 and 23 can be achieved, and 2) the closing magnetic core 34 is insulated from the mounting substrate. As a result, a choke coil suitable for being mounted onto the substrate can be obtained.

10 Embodiment 4

The fourth exemplary embodiment is described hereinafter by referring to Figs. 32-35. The basic structure is same as that of the second exemplary embodiment, thus different points only are described here. Regarding the terminal base 24, the support protrusions 49 disposed on each corner of the base plate 26 do not have a tapered notch 51 which could position the insulating sheet 33, and only a taper 50 is provided instead. The taper 50 guides the coreless coil 20 when the coreless coil 20 is assembled. The notch 38 is provided on the I-shape magnetic core 40 of the closing magnetic core 34. The notch 43 is provided on an edge of the E-shape magnetic core 39, and the cavity portion 44 is provided inside of the E-shape magnetic core 39. The insulating sheet 33 does not have the flap 52 for positioning, but has a hole 62 corresponding to the center magnetic leg 35 instead.

According to this structure, the choke coil illustrated in Figs. 34 and 35 are assembled through the following steps: first, a) incorporate the coreless coil 20 with the I-shape magnetic core 40, second, b) bend the terminals 22 and 23 and fit them into the terminal base 24 to join the coreless coil 20 to the triangular protrusion 27, third, c) fit the triangular protrusion 27 into the notch 38 for positioning, then, d) fit the hole 62 of the insulating sheet 33 into the center magnetic leg 35 of the E-shape magnetic core 39, and finally, e) incorporate the E-shape magnetic core 39 with the terminal base 24 by fitting the center magnetic leg 35 into the cylinder 25, which ensures the positioning of the E-shape magnetic core 39. The choke coil illustrated in Figs. 34 and 35 is thus completed.

This structure has the following advantages: 1) the I-shape magnetic core 40 is automatically positioned by the terminal base 24, and 2) the insulating sheet 33 is positioned by the center magnetic leg 35 of the E-shape magnetic core 39. These advantages benefit the choke coil when it is manufactured.

5

Embodiment 5

The fifth exemplary embodiment is described hereinafter by referring to Figs. 36-41. In those Figs., the coreless coil 20, closing magnetic core 34, and insulating sheet 33 have the same structures as those in the second exemplary embodiment, while only the terminal base 24 has a
10 different structure. Namely, the terminal base 24 to which the coreless coil 20 is mounted forms a case comprising the cylinder 25, the base plate 26 and an insulating wall 63. The insulating wall 63 functions as an insulating layer between the coreless coil 20 and both the outer magnetic legs 36, and is disposed on the outer edge of the base plate 26.

According to the above structure, the choke coil illustrated in Figs. 40 and 41 is assembled
15 through the following steps: first, a) incorporate the coreless coil 20 with the terminal base 24 shaped like a case, second, b) bent the terminals 22 and 23, third, c) insert the cylinder 25 into the center magnetic leg 35 of the E-shape magnetic core 39, the assembled product up to this point is illustrated in Fig. 38, d) position the insulating sheet 39 on the terminal base 24 as shown in Fig. 39, and e) incorporate the I-shape magnetic core 40 thereon, and complete the choke coil.

20 In this structure, the terminal base 24 has the insulating wall 63 on the outer edge of the base plate 26, and the terminal base 24 is shaped like a case. This structure provides the following advantage: the outer turn of coreless coil 20 is insulated from the outer magnetic leg 36 of the closing magnetic core 34, whereby a damage to the coreless coil 20 in the assembly process can be prevented, and as a result, work efficiency and product reliability are improved.

25

Embodiment 6

The sixth exemplary embodiment is described hereinafter by referring to Figs. 42-46.

The coreless coil 20 in this embodiment is made of flat type wire or foil type wire 21. The wire coils itself, and forms the coreless coil 20. Plate-type terminals 64 and 65 are connected to

the plate-type conductor 21 by ultrasonic bonding or welding at places near to both the ends of the conductor 21 as shown in Fig. 46. The terminals 64 and 65 comprises a first part having a width B which is connected to the conductor 21 and a second part having a wider width C. A taper 66 is formed at respective boundary parts between the first and second parts in order to absorb the width difference. Since lead sides of the terminals 64 and 65 have a wider area, a more stable mounting can be expected and heat dissipation of the coreless coil 20 is improved. The taper 66 smoothes a current running on the terminals 64 and 65 as well as increases the strength of the terminals against bending force. Thanks to the ultrasonic bonding or welding employed to connecting the terminals 64 and 65 to the plate-type conductor 21, the connection cannot be broken due to the heat applied to the circuit board during mounting process. The coreless coil 20 coupled to the terminals 64 and 65 is molded into the terminal base 24 by insulating synthetic resin, which forms a coil part 67. On the terminal base 24, the triangular protrusion 27 is provided on one side of a bottom face, a protrusion 68 is provided on both the end faces of the upper face, and a cavity is provided on both the sides so that the terminals 64 and 65 fit the cavities when the terminals are bent.

The closing magnetic core 34 is incorporated with the coil part 67. The closing magnetic core 34 comprises E-shape magnetic core 39 and I-shape magnetic core 40 both made of manganese ferrite sintered body. On the common magnetic yoke 37 of the E-shape magnetic core 39, the notch 38 is provided so that the triangular protrusion 27 can be fit therein. On the I-shape magnetic core 40, a notch 70 is provided on the edges opposite to each other into which the protrusions 68 provided on the terminal base 24 can be fit.

The terminal 64 coupled to the inner face of the coreless coil 20 is led out with a slant, so that the terminal 65 coupled to the outer face of the coreless coil 20 can be led out at the bottom of the terminal base 24 with an identical form to the terminal 64. Accordingly, both of the terminals do not have any difference in direction when the choke coil is mounted to the substrate. As a result, mounting efficiency is improved.

The choke coil illustrated in Figs. 44 and 45 is assembled through the following steps: first, a) incorporate the E-shape magnetic core 39 having the cylindrical center magnetic leg 35 with the terminal base 24 (i.e., the coil part 67) from its bottom face, second, b) fit the triangular

protrusion 27 into the notch 38 for ensuring the positioning, third, c) fit the protrusion 68 of the terminal base 24 into the notch 70 so that the I-shape magnetic core 40 is incorporated with the terminal base 24, and finally, d) bend upward the terminals 64 and 65 led out from the bottom face of the terminal base 24 to fit into the cavity 69 provided on the side faces of the terminal base 24.

5 The choke coil is thus completed.

The above structure has the following advantages: 1) the coreless coil 20 is mounted on the face contacted to the closing magnetic core 34 via an insulating layer because the surface of coreless coil 20 is molded by insulating synthetic resin, as a result, no damage is expected to the coreless coil 20, the terminals 64 and 65 in the assembly process. Also, heat dissipation of the coreless coil 20 is improved, and the size thereof as well as a number of components can be reduced, 2) since the positioning is achieved between the protrusion 68 of the terminal base 24 and the notch 70 of the I-shape magnetic core 40, assembly efficiency and product reliability are improved, and 3) because the terminals 64 and 65 are fit into the cavity 69 on the side face of the terminal base 24, a mounting space on the mounting substrate can be reduced.

10 Regarding the terminals 64 and 65, the choke coil as shown in Fig. 43 can be mounted depending on a certain condition. The notch 38 accepting the triangular protrusion 27 can be provided on the I-shape magnetic core 40. The notch 70 accepting the protrusion 68 of the terminal base 24 can be provided on the E-shape magnetic core.

20

Industrial Applicability

As discussed in the above embodiments, the choke coil of the present invention comprises the following elements: (a) a closing magnetic core including a center magnetic leg, outer magnetic legs and a common magnetic yoke, (b) an coreless coil coiling a plate-type wire made of flat-type wire or foil-type wire to form itself, the coreless coil being mounted to the center magnetic leg of the closing magnetic core, where two terminals are coupled to respective ends of the plate-type wire of the coreless coil, and at least one of the terminals disposed at an inner turn of the coreless coil is led out to outside through a notch or an opening provided on either side of the common magnetic yoke of the closing magnetic core. Accordingly the thickness of the inside terminal of the closing magnetic core does not influence a window height of the closing magnetic core,

thereby eliminating a dead space along the window height direction, increasing a space factor, lowering the window height of the closing magnetic core. On the other hand, the thickness of the inside terminal can be increased, i.e., the sectional area of the terminal can be widened to accommodate a larger current. As a result, the choke coil of thinner and lower in size and

5 accomodating a larger current can be produced.

Further, when the coreless coil is mounted on a face contacted to the closing magnetic core via an insulating layer, the coreless coil and the terminals are prevented from being damages during assembly. As a result, a choke coil of better efficiency in assembly and the higher reliability can be produced.

10

What is claimed is:

1. A choke coil comprising:
 - 5 a closing magnetic core including:
 - a center magnetic leg,
 - a outer magnetic leg, and
 - a common magnetic yoke, and
 - a coreless coil coiling a plate-type wire made of one of flat type wire and foil type wire,
- 10 said coreless coil being mounted to the center magnetic leg, wherein a terminal is coupled to both ends of the plate-type wire of the coreless coil and at least a terminal coupled to an inside end is led out to outside through one of a notch and an opening provided to one side of said common magnetic stool of said closing magnetic core.
- 15 2. The choke coil as defined in Claim 1, wherein said coreless coil is mounted on a face contacted to the closing magnetic core via an insulating layer.
3. The choke coil as defined in Claim 1 or Claim 2, wherein said closing magnetic core comprising: a combination of EE-shape, EI-shape and TU-shape closing magnetic cores.
- 20 4. The choke coil as defined in Claim 3, wherein said closing magnetic core comprising: a manganese ferrite core.
5. The choke coil as defined in Claim 1 or Claim 2, wherein said closing magnetic core
- 25 comprising: a center magnetic leg including magnetic gap thereon.
6. The choke coil as defined in Claim 1 or Claim 2, wherein said closing magnetic core comprising: a center magnetic leg including magnetic gap thereon.

7. The choke coil as defined in Claim 1 or Claim 2, wherein said center magnetic leg of the closing magnetic core has a cross section shaped in one of a circle, an oval and an ellipse

8. The choke coil as defined in Claim 1 or Claim 2, wherein, on a free side of said common magnetic yoke, one of a cavity, a notch and a hole is provided at a place corresponding to the terminal situated inside of the common magnetic yoke, wherein another side of said common magnetic yoke has been provided with one of a notch and an opening.

9. The choke coil as defined in Claim 1 or Claim 2, wherein EI-shape magnetic core is employed as said closing magnetic core, wherein said I-shape magnetic core has one of a notch and an opening through which said terminal coupled to the inside end of the coreless coil is led out.

10. The choke coil as defined in Claim 1 or Claim 2, wherein a thickness of a free side of said common magnetic yoke of the closing magnetic core is 65-90% that of another side where one of the notch and the opening for pulling out the terminal is provided.

11. The choke coil as defined in Claim 2, wherein said coreless coil is housed in one of a resin molded case and an insulating case.

12. The choke coil as defined in Claim 1 or Claim 2, wherein said coreless coil comprises a self-welding flat-type insulating wire.

13. The choke coil as defined in Claim 1 or Claim 2, wherein said coreless coil is shaped in one of a circle, an oval and an ellipse responsive to a shape of said center magnetic leg of the closing magnetic core.

14. The choke coil as defined in Claim 2, wherein both ends of the plate-type wire constituting said coreless coil are bent so that each end protrudes inside and outside respectively.

15. The choke coil as defined in Claim 1 or Claim 2, wherein a spacer is disposed between the plate-type wire and a connecting portion of the terminal coupled to each end of the coreless coil.

5 16. The choke coil as defined in Claim 12, wherein a distance between the end of the plate-type wire and the connecting portion of the terminal is slightly extended.

17. The choke coil as defined in Claim 1 or Claim 2, wherein the insulating layer formed between the coreless coil and the closing magnetic core comprises a positioning protrusion which
10 fits into one of the notch and the opening provided to the one side of the common magnetic yoke of the closing magnetic core.

18. The choke coil as defined in Claim 1 or Claim 2, wherein the insulating layer formed between the coreless coil and the closing magnetic core comprises a terminal base.

15

19. The choke coil as defined in Claim 18, wherein said terminal base comprises:

a base plate, and

a cylinder located in a center of the terminal base, wherein said cylinder engages with the center magnetic leg of the closing magnetic core.

20

20. The choke coil as defined in Claim 19, wherein said cylinder of the terminal base comprises:

a cylinder having thickness deviation, and

a guiding portion provided at a thicker part of said cylinder for engaging with the
25 terminal of the coreless coil.

21. The choke coil as defined in Claim 20, wherein said cylinder comprises:

a fixing part provided at the thicker part of said cylinder for fixing a bent portion of the end of the coreless coil.

30

22. The choke coil as defined in Claim 18, wherein said terminal base comprises:
a cylinder, and
a base plate,
wherein said cylinder and said base plate are independently built and then coupled
5 together.

23. The choke coil as defined in Claim 18, wherein said terminal base comprises:
a base plate having a support protrusion at each corner thereof.

10

24. The choke coil as defined in Claim 23, wherein said support protrusions at each corner
have a taper on a face into which an outer turn of the coreless coil is inserted.

25. The choke coil as defined in Claim 23, wherein a part of said support protrusion of the
15 terminal base has a fixing part for fixing a bent portion provided at an outer turn of the coreless
coil.

26. The choke coil as defined in Claim 17, wherein a terminal base has the coreless coil
incorporated into said terminal base as one molding.

20

27. The choke coil as defined in Claim 1, wherein the coreless coil is molded into an EI-
shape closing magnetic core of which at least one of two edges corresponding to edges of an I-
shape magnetic core has a notch to which a terminal base is mounted, and one face of the terminal
base has a protrusion engaging with a notch of the I-shape magnetic core.

25

28. The choke coil as defined in Claim 2, wherein the insulating layer between the coreless
coil and the closing magnetic core comprises an insulating sheet.

29. The choke coil as defined in Claim 28, wherein said insulating sheet has an engaging part at each outside corner thereof for engaging with one of the outer magnetic leg, an insulating enclosure of the coreless coil, and a support protrusion for the insulating sheet to be positioned.

5 30. The choke coil as defined in Claim 28, wherein said insulating sheet has an opening which fits into the center magnetic leg of the closing magnetic core.

31. The choke coil as defined in Claim 1 or 2, wherein the terminal coupled to both ends of coreless coil employs one of a plate-type terminal and a pin-type terminal.

10

32. The choke coil as defined in Claim 31, wherein said terminal is formed to fit into a guide groove on a lower face of a positioning part so formed to fit into the notch provided on the closing magnetic core, said terminal being led out to be flush with a bottom face of the choke coil.

15 33. The choke coil as defined in Claim 1 or 2, wherein said terminal comprises a portion coupled to the coreless coil, and another portion led out from a terminal base, wherein said another portion has a wider width.

20 34. The choke coil as defined in Claim 33, wherein said terminal has a taper for absorbing a width difference at a boundary part between two portions having different width.

35. The choke coil as defined in Claim 1 or 2, wherein the terminal is coupled to the coreless coil by one of ultrasonic bonding and welding.

25 36. The choke coil as defined in Claim 1 or 2, wherein the two terminals led out from a terminal base has a same mounting face when being mounted onto a substrate.

37. The choke coil as defined in Claim 1 or 2, wherein the terminal led out from a terminal base is so bent to be along a side face of a terminal base.

30

38. The choke coil as defined in Claim 1 or 2, wherein an insulating plate is provided beneath a bottom face of the closing magnetic core for guiding the terminal.

Abstract

The present invention relates to a choke coil utilized in a variety of electronic products both for industrial use and consumer use, and aims to provide a choke coil that is thinner in size, accommodates a larger current, provides better efficiency in assembly and higher reliability. The

5 choke coil of the present invention comprises a closing magnetic core having a center magnetic leg, an outer magnetic leg 36 and a common magnetic yoke. A coreless coil winds a plate-type wire around the center magnetic leg of the closing magnetic core to form itself, and is mounted to the closing magnetic core. At least one terminal coupled to an inner turn of the coreless coil out of terminals coupled to both ends of the plate-type wire of the coreless coil is led out from a

10 notch provided on one side of the common magnetic yoke of the closing magnetic core.

Reference Numerals in the Drawings:

- 20 coreless coil
- 21 plate-type wire
- 22 inner terminal
- 5** 23 outer terminal
- 24 terminal base
- 25 cylinder
- 26 base plate
- 27 triangular protrusion
- 10** 28 vertical groove
- 29, 30 terminal hole
- 31, 32 terminal groove
- 33 insulating sheet
- 34 closing magnetic core
- 15** 35 center magnetic leg
- 36 outer magnetic leg
- 37 common magnetic yoke
- 38 notch
- 39 E-shape magnetic core
- 20** 40 I-shape magnetic core
- 41 cavity notch
- 42 magnetic gap

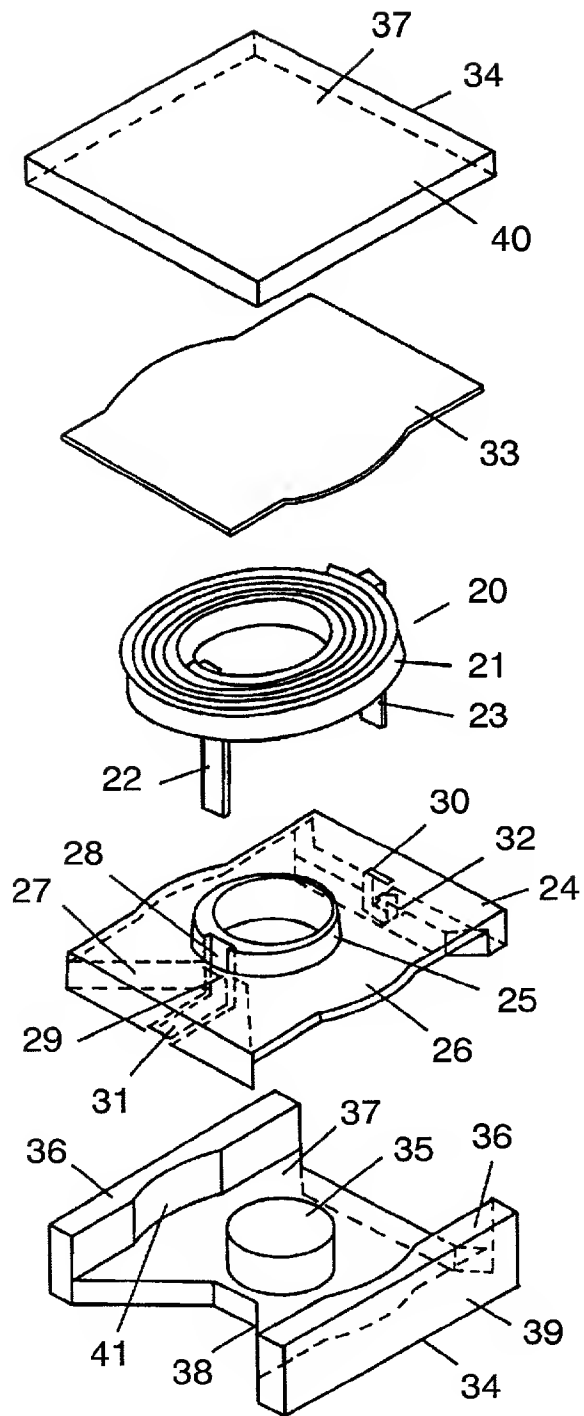


FIG. 1

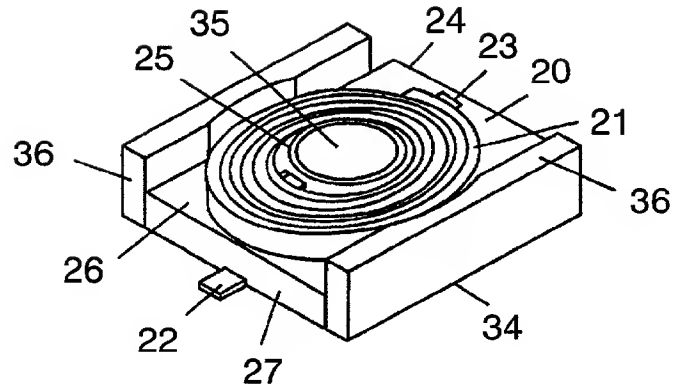


FIG. 2

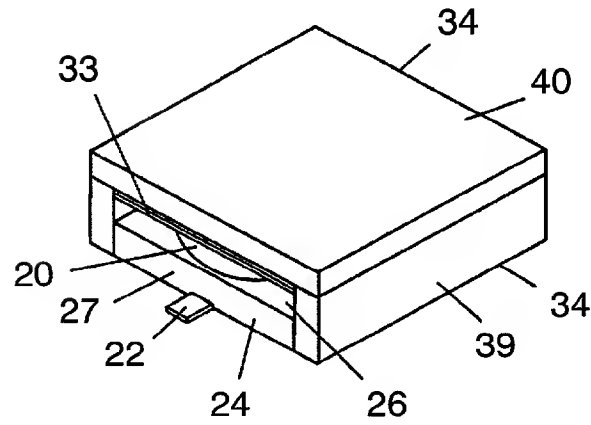


FIG. 3

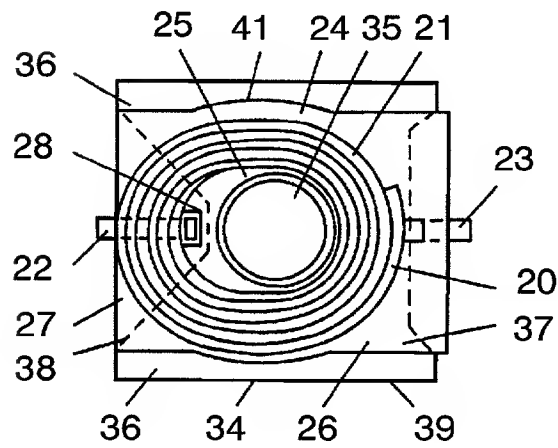


FIG. 4

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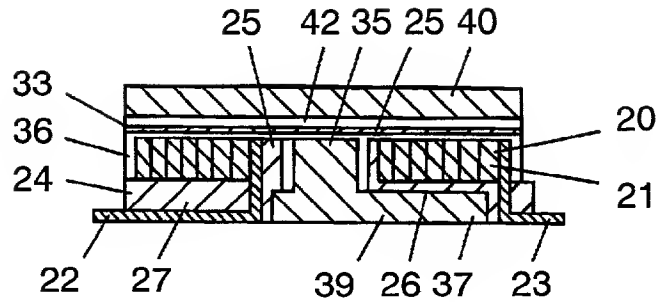


FIG. 5

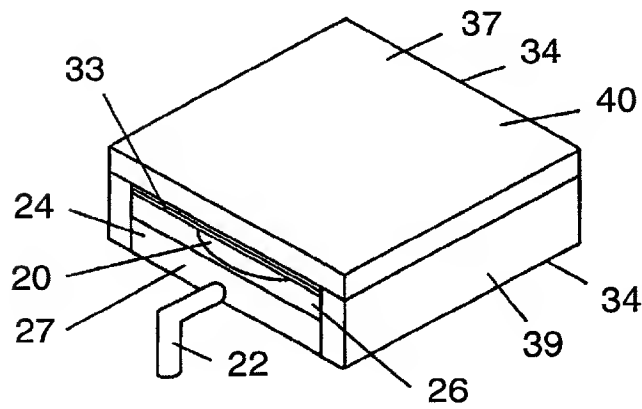


FIG. 6

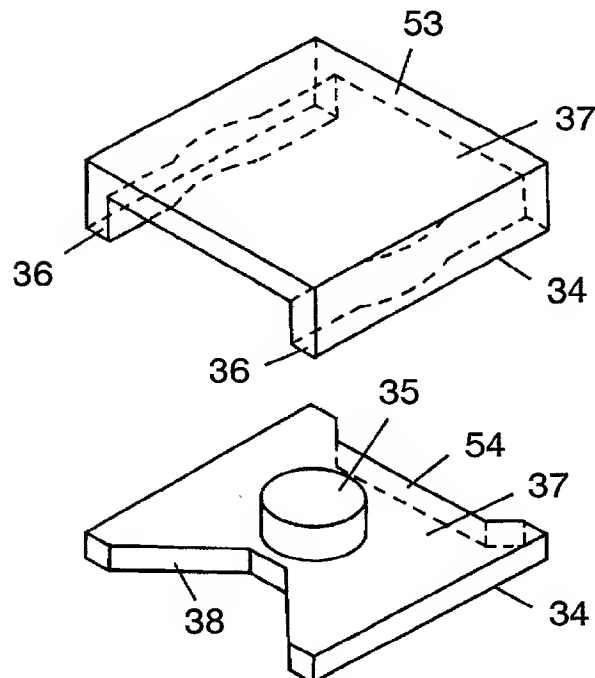


FIG. 7

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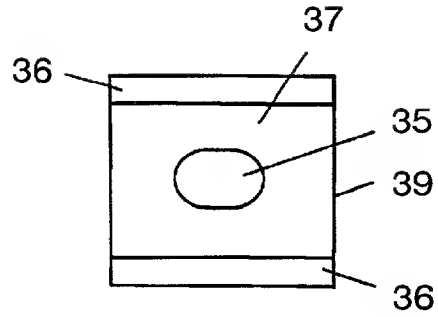


FIG. 8

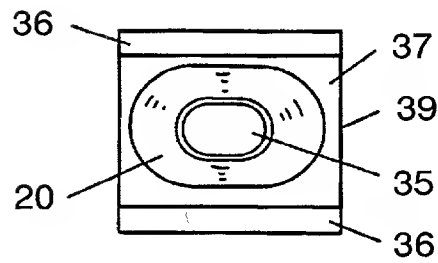


FIG. 9

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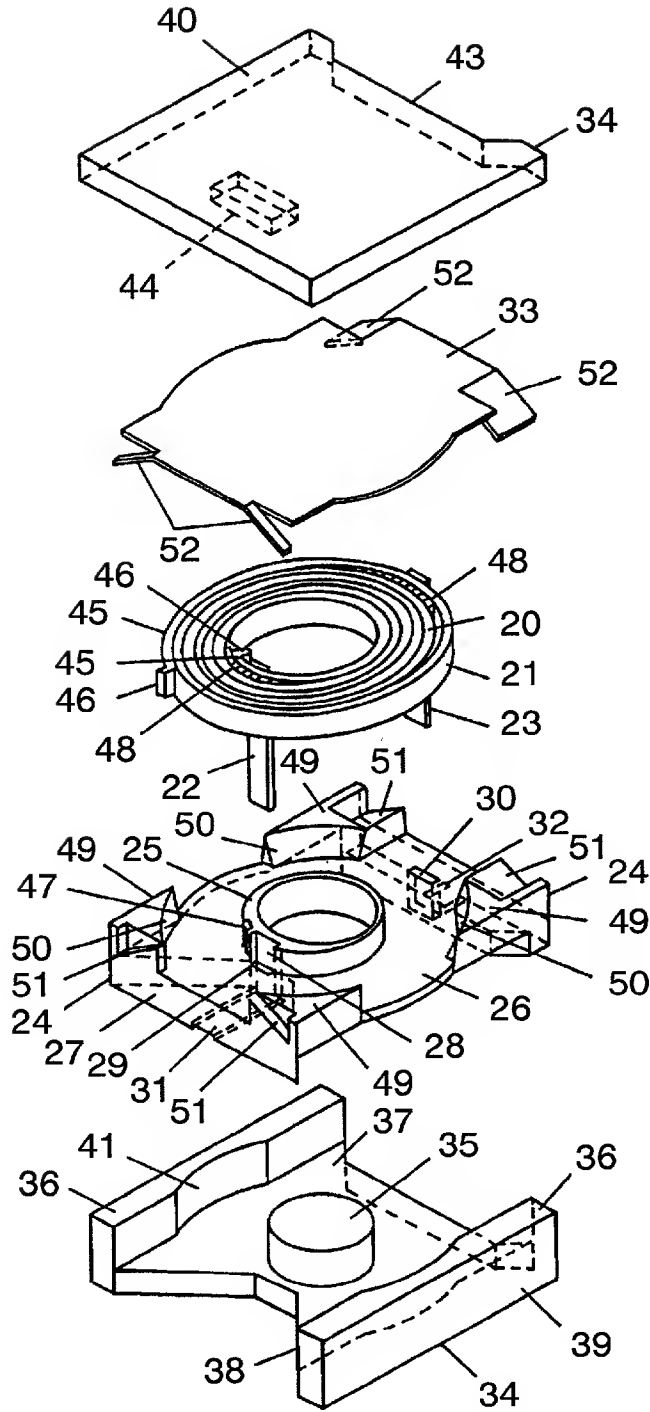


FIG. 10

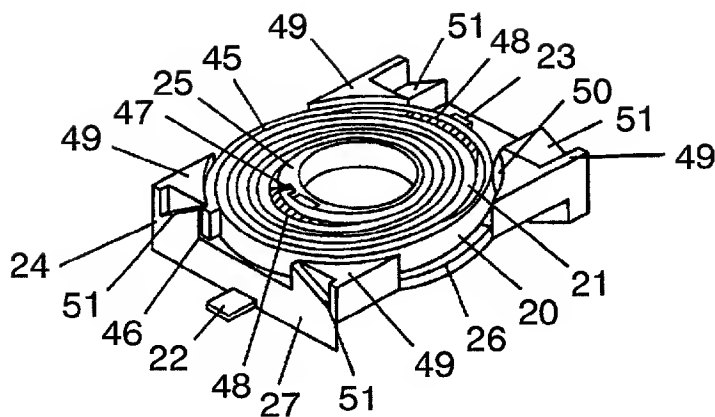


FIG. 11

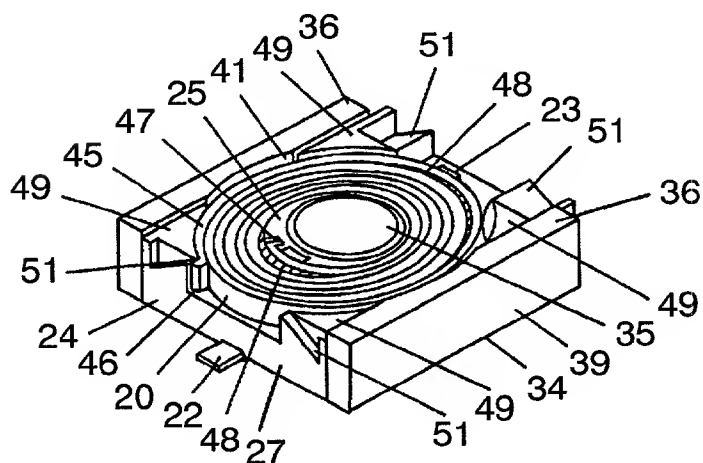


FIG. 12

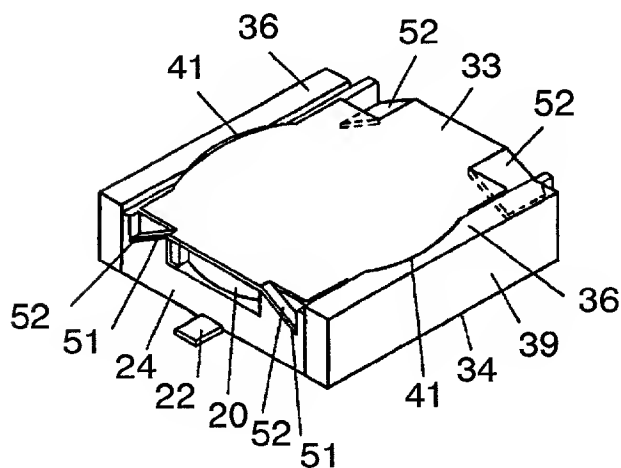


FIG. 13

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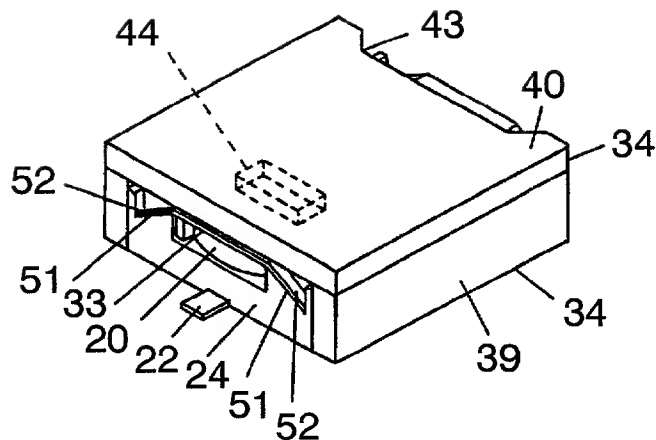


FIG. 14

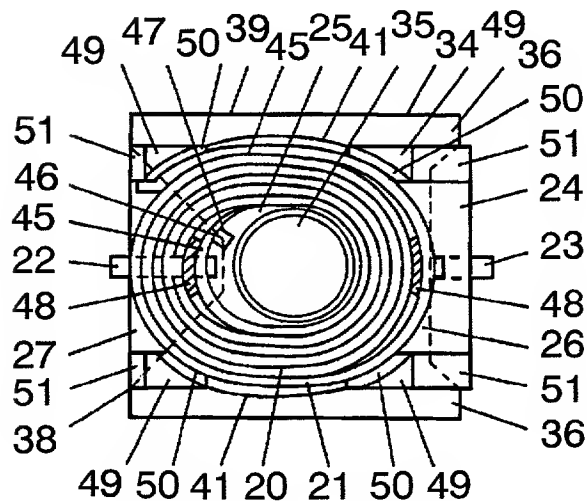


FIG. 15

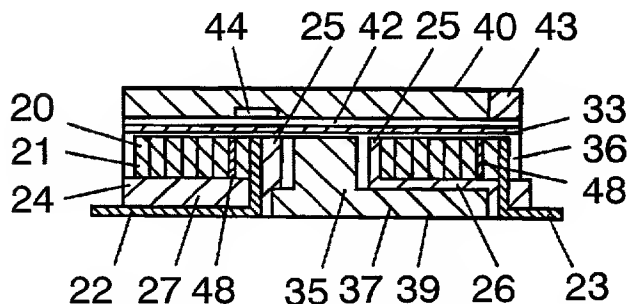


FIG. 16

FIG. 17A

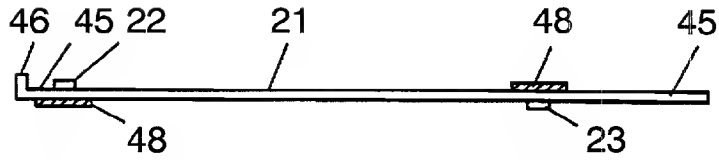


FIG. 17B

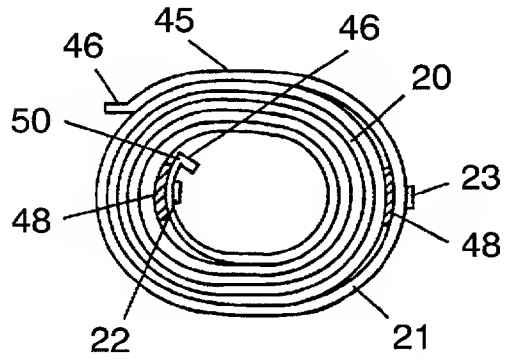
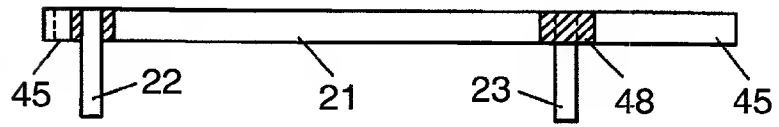


FIG. 18

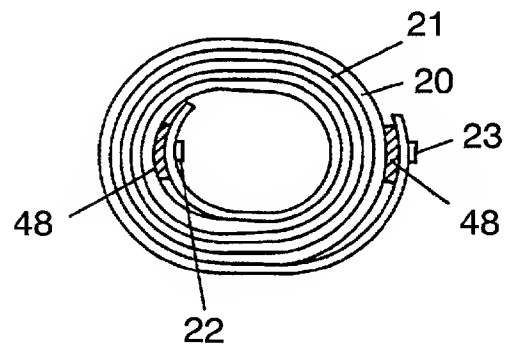


FIG. 19

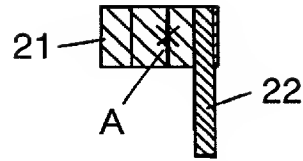


FIG. 20

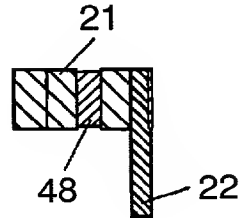


FIG. 21

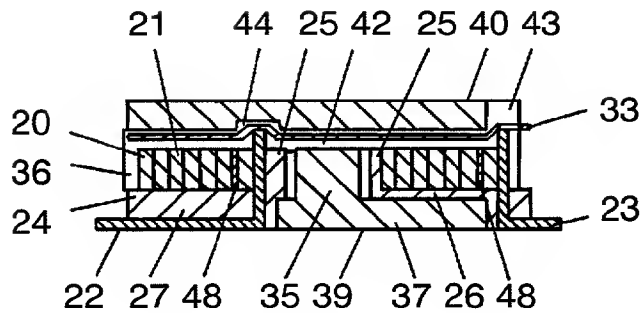


FIG. 22

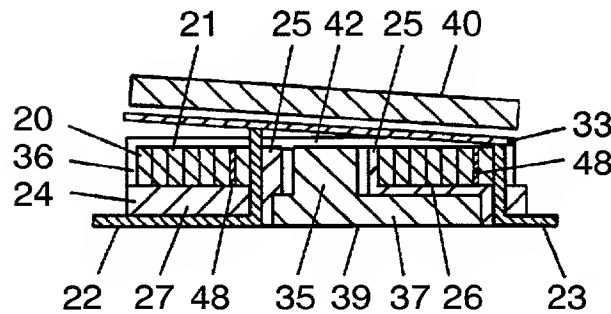


FIG. 23

FIG. 26A

FIG. 26B

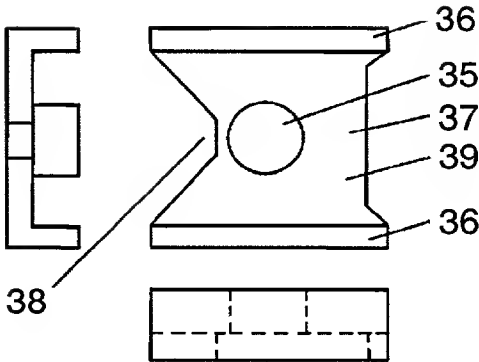


FIG. 26C

FIG. 27A

FIG. 27B

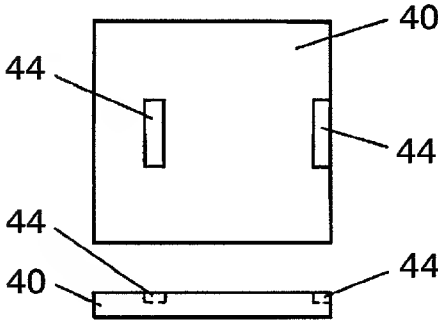
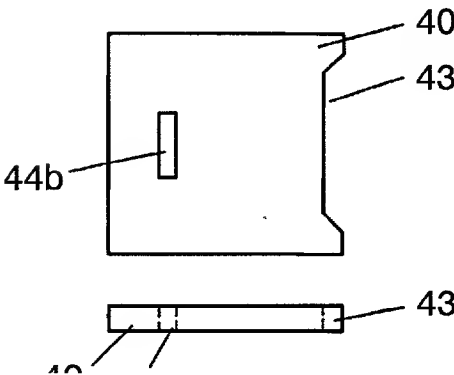


FIG. 28A

FIG. 28B



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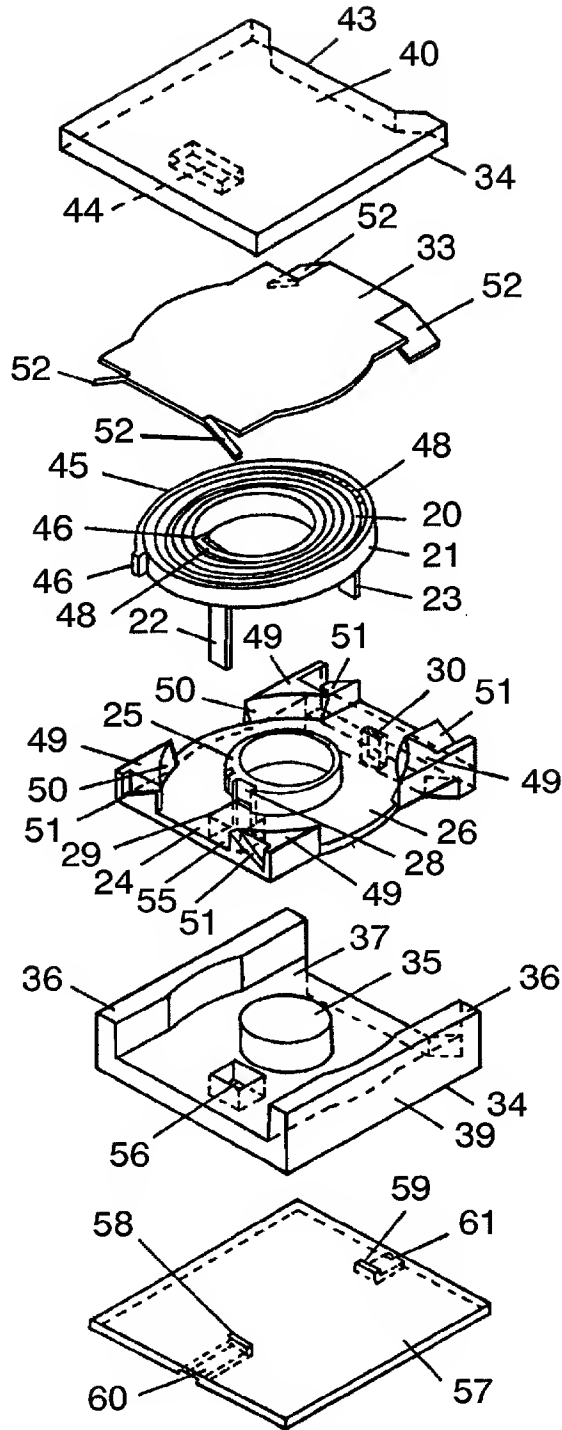


FIG. 29

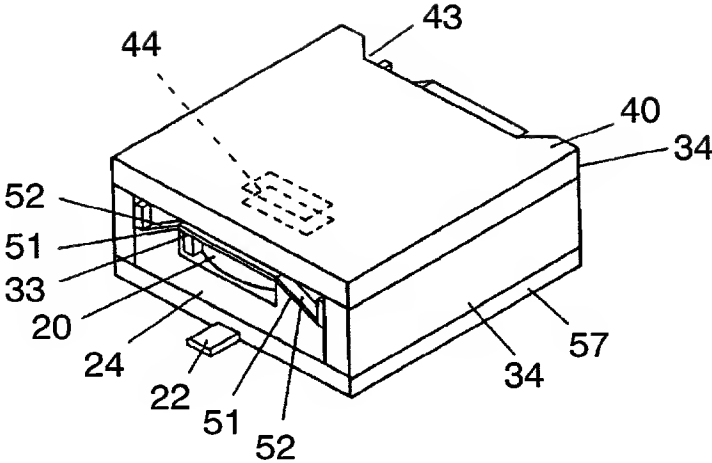


FIG. 30

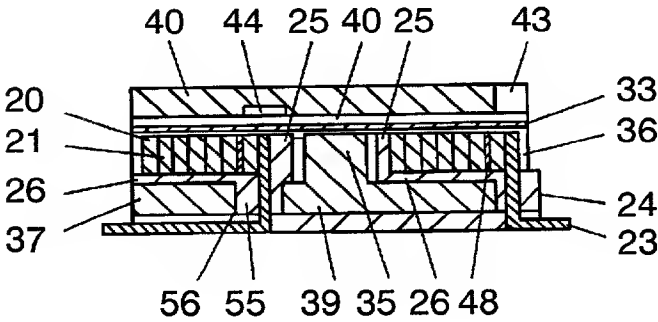


FIG. 31

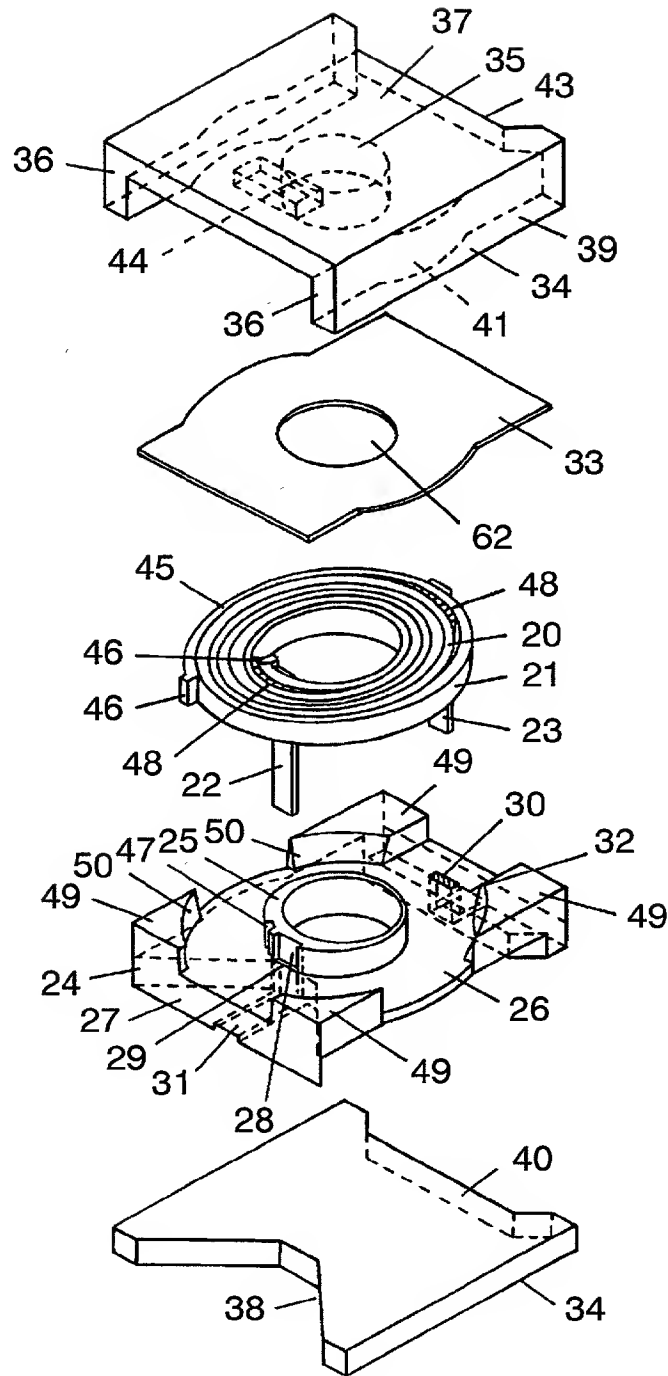


FIG. 32

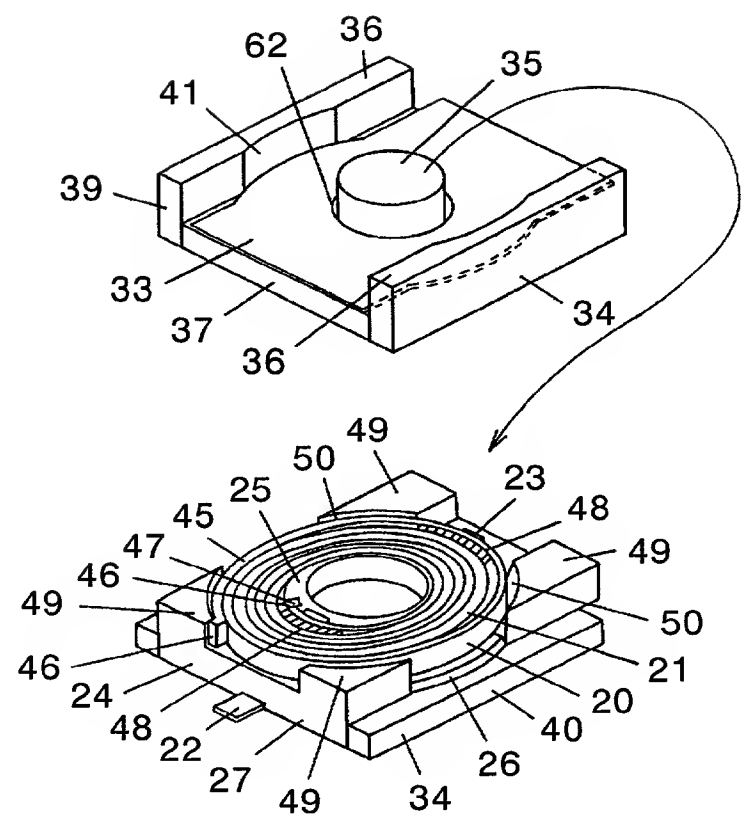


FIG. 33

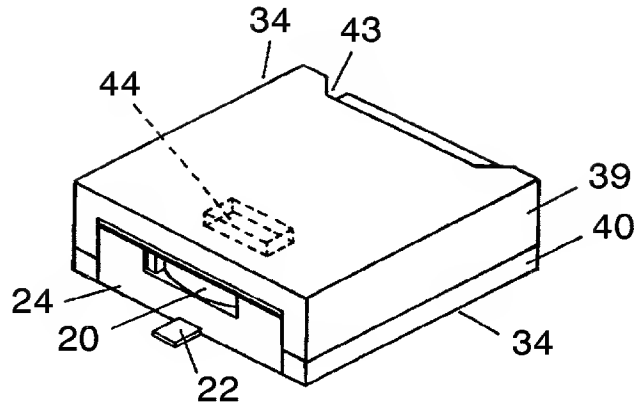


FIG. 34

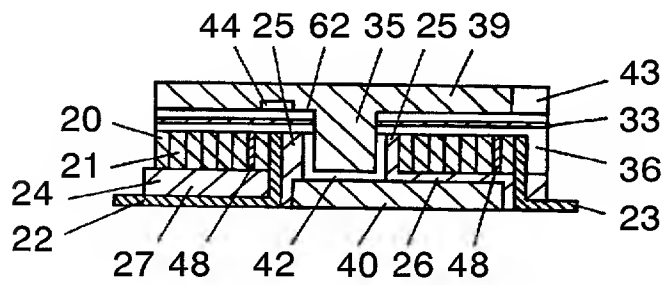


FIG. 35

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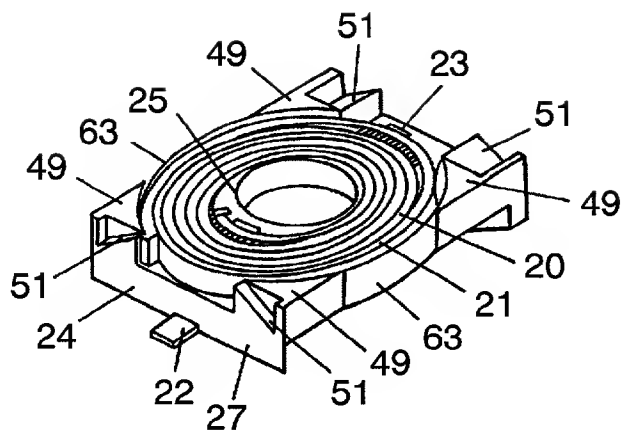


FIG. 37

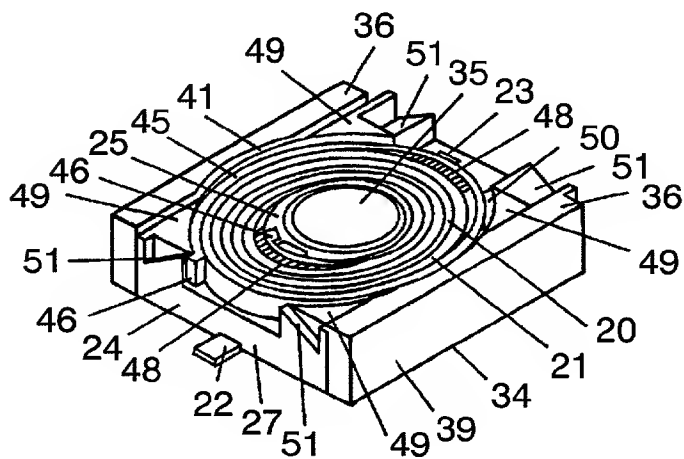


FIG. 38

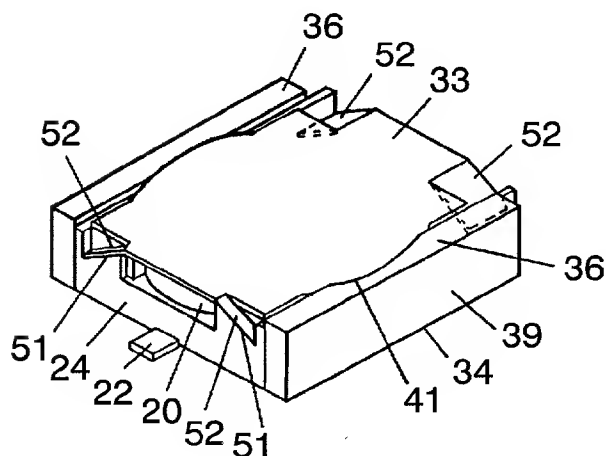


FIG. 39

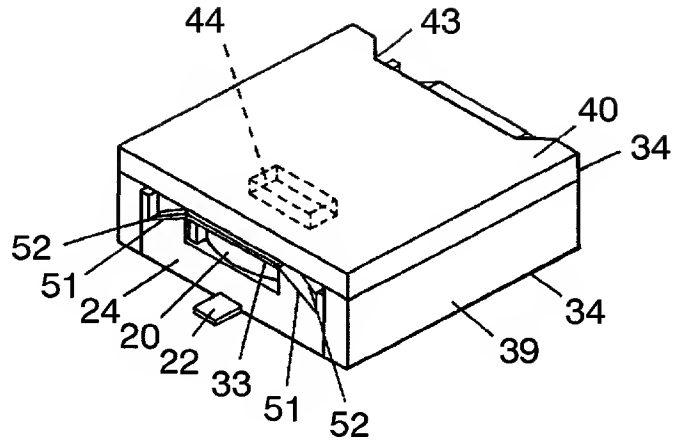


FIG. 40

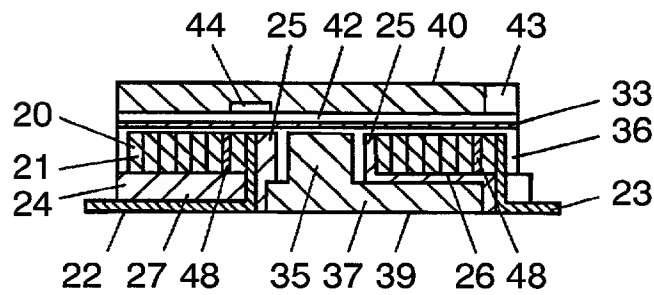
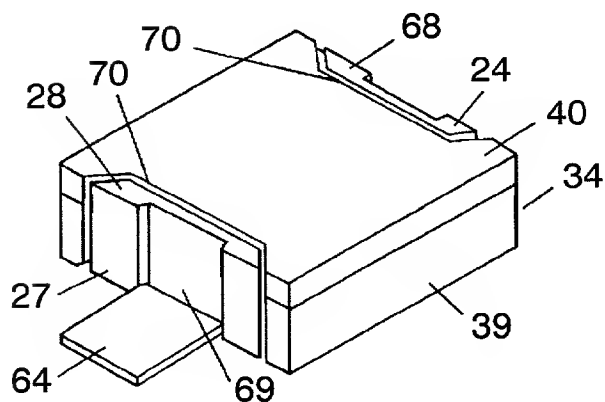
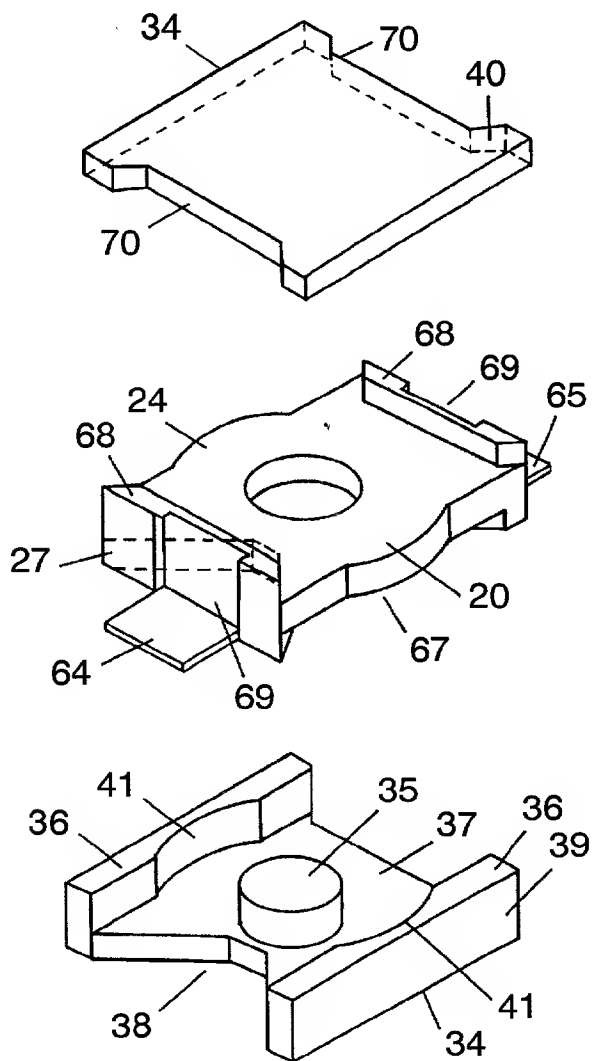


FIG. 41

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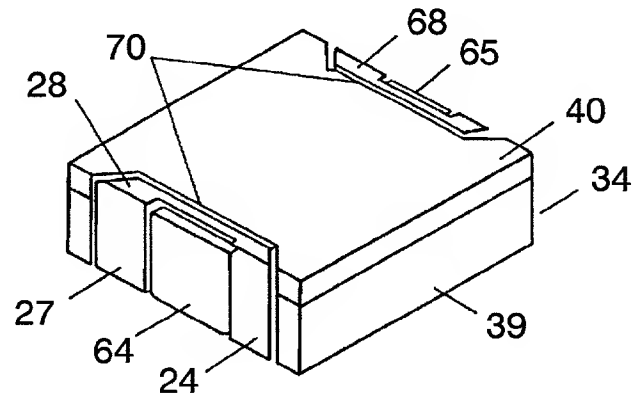


FIG. 44

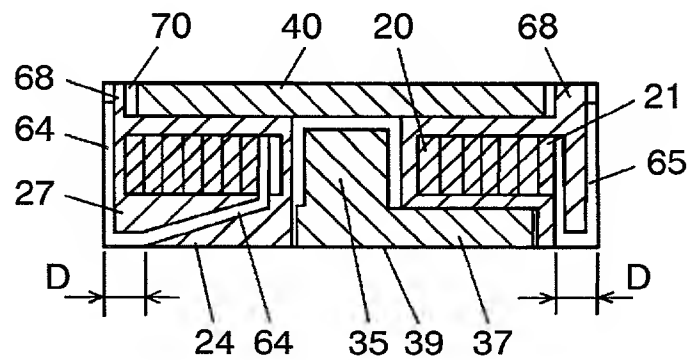


FIG. 45

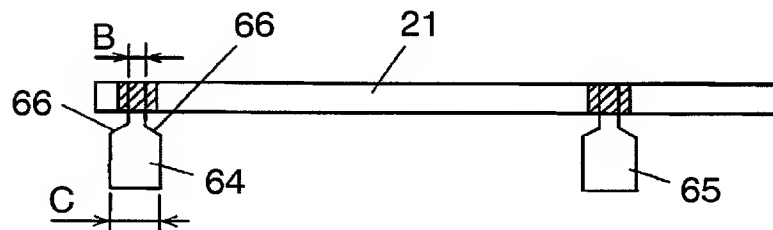


FIG. 46

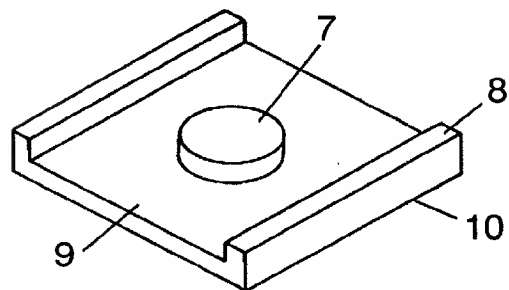
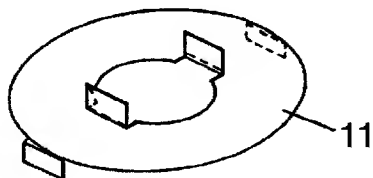
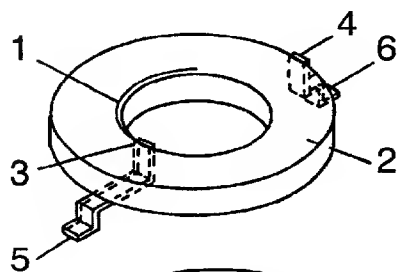
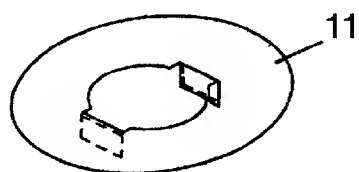
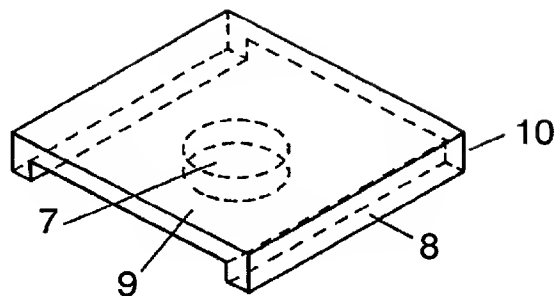


FIG. 47

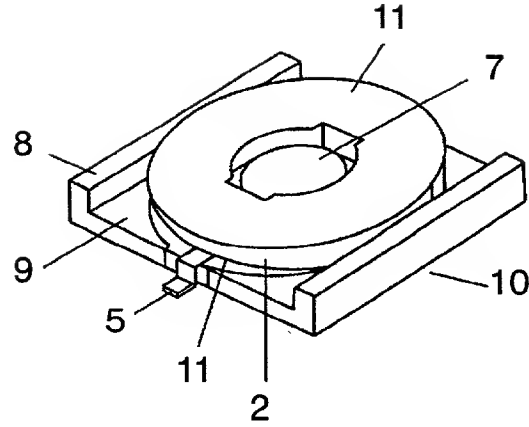


FIG. 48

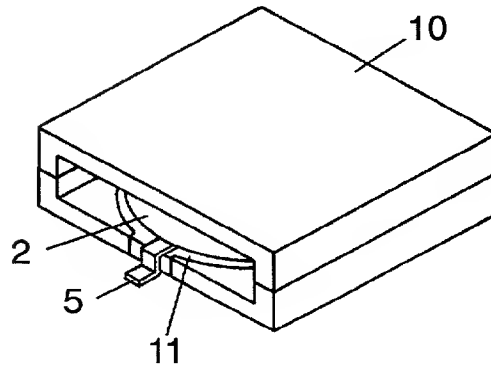


FIG. 49

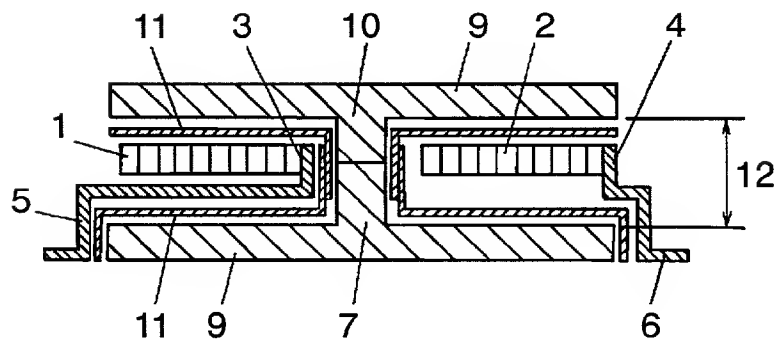
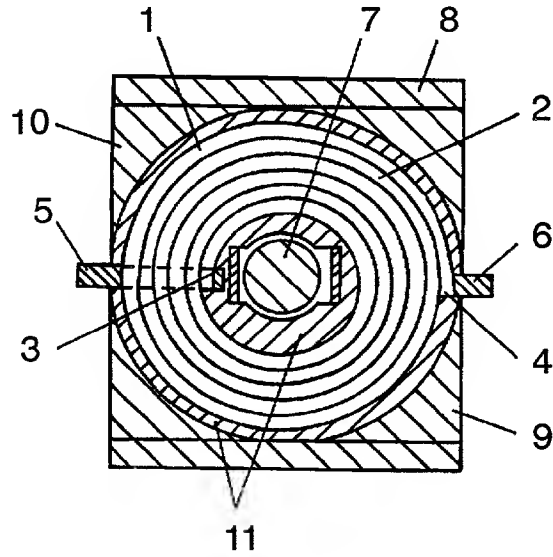


FIG. 50

APPROVED	O.G. FIG.	
BY	CLASS	SUBCLASS
DRAFTSMAN		

09/091805



APPLICATION FOR UNITED STATES PATENT
DECLARATION AND POWER OF ATTORNEY

I hereby declare, as a named inventor of the invention identified herein, that my residence, post office address and citizenship are as stated below next to my name; that I verify and believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE: **CHOKE COIL**

which is described and claimed in the specification: a. attached hereto; b. X filed 6/23/98 as U.S. Patent Appln. Serial No. 09/091,805 and amended on ; c. X identified by the Assignee as reference number P15628-01 and assigned by my attorney ATTORNEY DOCKET NUMBER MATS:006.

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above, and hereby acknowledge the duty to disclose information of which I am aware which is material to this application for patent on the invention described in the above-identified specification in accordance with 37 C.F.R. §1.56.

I hereby claim priority benefits under 35 U.S.C. §119 based on the following foreign applications(s) filed within one year prior to this application and/or under 35 U.S.C. § 365 for the following PCT International Application:

PRIORITY: **PCT/JP97/03833 filed October 23, 1997**

The following applications for patent or inventor's certificate on this invention were filed in countries foreign to the United States of America either (a) more than one year prior to this application, or (b) before the filing date of the above-named foreign priority application(s) (INSERT "NONE" IF NO CORRESPONDING CASES): **None**

I hereby appoint Marc A. Rossi (Reg. No. 31,923) as my attorney of record with full power of substitution and revocation to prosecute this application, to transact all business in the Patent Office, and to insert on this document the Attorney Docket Number assigned to this application. I further direct that all correspondence in connection with this application be sent to my attorney at the address provided below:

ROSSI & ASSOCIATES
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ASHBURN, VA 20146-0826
(703) 904-4332

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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ADDITIONAL INVENTORS PROVIDED ON ATTACHED PAGES YES NO X